U.S. Government Policies Relating to International Cooperation on Energy

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1.0 Introduction

U.S. citizens have important interests at stake not only in energy developments and choices in this country but in those occurring around the world:

- World investments in energy-supply technology are in the range of $400 billion per year and rising, and most of those purchases are made outside the United States -- an increasing fraction of them in developing countries. This is an immense market for U.S. energy-technology firms and, thus, an opportunity for the U.S. economy.

- The macroeconomic, environmental, and national-security risks to the United States in the energy domain – which correctly preoccupy us in the pursuit of Federal energy policies to address them -- cannot in fact be successfully addressed by U.S. actions alone. Oil is a global market and natural gas is becoming so, meaning that global demand in relation to supply governs the world price. Air pollutants cross not just national boundaries but oceans -- to an extent that will make it impossible for parts of the United States to meet air-pollution goals unless emissions are controlled in Asia. A nuclear-energy accident or diversion of nuclear-explosive materials anywhere is potentially a disaster for everyone everywhere. And greenhouse-gas emissions will need to fall below their business-as-usual trajectories all over the world, not just in the United States and other industrial nations, if the risks of global climate change are to be acceptably reduced.

- Energy choices made in developing countries will be important determinants of the pace, extent, and sustainability of economic development there, which in turn will influence the political stability of those regions as well as their potential as markets for U.S. goods, services, and technology. Conversely, energy decisions (or the lack of them) that create or perpetuate economic or environmental impoverishment -- including failure to provide the energy essential for meeting basic human needs -- must be regarded as contributors to the conditions of frustration and despair that can breed instability, conflict, and terrorism.

These important U.S. interests in energy decisions and energy markets abroad are the primary motivation for a significant dimension of U.S. energy policy focused on facilitating and in some instances implementing bilateral and multilateral cooperation in energy technology and

policy. Additional benefits of international cooperation on energy research, development, and demonstration are the sharing thus achieved in the costs and economic risks of this activity, as well as the accelerated pace of energy-technology advances deployable in the United States resulting from improved access to insights and experience from the energy sectors of other countries.

International cooperation on energy technology and policy may have any of a number of focuses, including:

- endorsing international energy cooperation through statements of intent or memoranda of understanding
- information/data collection and sharing
- education, training, and technical exchanges
- cooperation in energy-technology research, development, and demonstration
- financing for accelerated deployment of energy options with transboundary public benefits
- implementation of project-based energy efficiency or air-pollution reduction efforts
- joint ventures in commercial-scale energy production and distribution
- licensing agreements for energy technology
- creation of joint strategic reserves and shortage-sharing arrangements
- joint development, coordination, or harmonization of regulatory and other policies

The indicated cooperative activities will sometimes be of a government-to-government, firm-to-firm, university-to-university, or NGO-to-NGO nature, but they can also include cross-sector partnerships in all combinations. Governments are not – and need not be – directly involved in all of these activities, but the availability of resources for many of them (and, to at least some extent, the incentives and disincentives for all of them) are matters of government policy.

In the United States government, the relevant determinations are made in a wide variety of agencies at the federal level – for example in the White House, the State Department, the Treasury Department, the Commerce Department, the Energy Department, the Justice Department, the Department of Homeland Security, the Trade and Development Agency, the Environmental Protection Agency, the Agency for International Development, and the National Science Foundation – as well as in the Congress and, to a lesser extent, at state and local levels. U.S. government facilitation (or inhibition) of international cooperation on energy occurs not only through the actions and policies of these and other entities acting on their own or in concert, but also through U.S. participation in international agencies such as the World Bank, the International Energy Agency, the International Atomic Energy Agency, the UN Environment Program, and the UN Development Program.

The diversity of government activities included in or affecting international energy cooperation and the large number of government-entity roles and relationships involved make it difficult to accurately map this terrain. So does the fuzziness of the boundary between energy and non-energy cooperation, in some instances, and the boundary between national and international activity, in others. Sometimes agencies compound these difficulties by being

deliberately ambiguous, in their budget and program documents, about which activities relate to international cooperation, because these activities are sometimes regarded as conspicuous targets for budget-cutters in the OMB or the Congress. For all of these reasons, it is difficult to estimate accurately how much money the U.S. government spends on international energy cooperation. But to give some idea of the overall size of the effort, the 1999 report of the President's Committee of Advisors on Science and Technology on international cooperation in energy-technology innovation (PCAST 1999) identified $235 million in federal expenditures on the technology-innovation dimension of international energy cooperation in FY1997, 57% of this sum in the DOE budget, 40% in the USAID budget, and 3% in other agencies.

In this paper, we: (1) provide an updated typology of U.S. federal government activities in support of bilateral and multilateral cooperation on energy technology and policy, with examples of some of the more visible and/or successful mechanisms and specific programs of different types; (2) summarize briefly the findings of other recent studies of this subject; and (3) offer our own recommendations about upgrading the international-cooperation dimension of U.S. government energy policy to better reflect the leverage of this set of activities in addressing the energy challenges and opportunities that confront this country.

2.0 Types of Cooperation

This paper focuses primarily on U.S. government-led international energy cooperation, but, as noted above, much additional international energy collaboration occurs among private sector actors (between firms and within multinationals), and among universities, research institutes, and non-governmental organizations. In the government-led category, there are at least four major types of cooperation, which we describe briefly here..

Cooperation on Energy-Technology Innovation

Cooperation on energy-technology innovation encompasses joint activities that build capacity for or carry out research, development, demonstration, and early-deployment of improved energy technologies.[1] International collaboration in this domain allows the United States to gain access to diverse R&D capabilities (such as facilities and expertise), to share costs of pre-competitive R&D, to reduce the costs of emerging technologies through accelerated learning, to enhance U.S. firms' understanding of, and access to, large commercial markets, and to accelerate the development and deployment of technologies whose use elsewhere improves regional or global economic, environmental, or political conditions.

Cooperative Initiatives Supporting Energy-Sector Financing and Management

There is a wide variety of collaborative policy initiatives that are being or could be explored and implemented in the areas of energy sector privatization and/or restructuring, technical codes and standards, environmental standards, and security-related measures. To provide just two examples, the U.S. government works with foreign governments on opening up

[1] By "early deployment" we mean pre-competitive deployment programs that help emerging technologies that could have significant public benefits break through the institutional and market barriers that often prevent new technologies from reaching widespread application.

their energy sectors to trade and investment by implementing policy measures that would improve transparency and remove regulatory barriers to foreign investment; and it undertakes environmental policy initiatives such as harmonization of emission and fuel-quality standards.

Cooperation in Managing International Energy Flows, Interactions, and Shortages

The U.S. energy-supply infrastructure is linked to and must be coordinated with that of countries to which it is linked in international trade in fuels and electricity. The issues involved include management of international pipelines, international electricity-grid connectivity, plans for the amelioration and allocation of shortages, measures to ensure the safety of LNG shipments and terminals against accidents and terrorist attack, and, for the longer term, exploration of the international dimensions of challenges associated with the emergence of hydrogen as a major energy carrier.

Cross-Cutting Initiatives in Information-Sharing, Education, and Training

Information-sharing, education, and training activities encompass a wide range of activities including: the organization of conferences, workshops, study tours, and informal meetings among government officials, experts, academics, NGOs, and private industry; the provision of in-country technical assistance by U.S. experts; education of foreign students in U.S. universities and vice versa; and support for U.S. researchers who are studying energy topics in other countries. A number of the intergovernmental organizations also play information-sharing roles, such as the International Energy Agency, which collects, compiles, and analyzes energy-related data, and publishes reports on relevant topics. At the governmental level, interactions between officials of the US and other countries allow for discussions and information-sharing on a range of topics. Efforts that promote greater transparency on energy topics are especially important because they enhance understanding about the energy challenges and opportunities in the other country.

3.0 Avenues for U.S. Government-Led International Energy Collaboration

Government Support to the Private Sector, Universities, NGOs, and National Labs

U.S. government support for international energy collaboration projects among the private sector, universities, non-governmental organizations (NGOs), and national labs is essential, because it is in this realm that much of the implementation work actually occurs. Not only do these organizations conduct much of actual work of international energy collaboration, but these projects foster significantly greater understanding within civil society across borders about the nature of energy problems and ideas for creative solutions. Although some governments (especially the European Union and Japan) offer significant levels of support for these kinds of activities, the U.S. government traditionally has provided more limited support, often tying it to efforts to expand markets for U.S. private industry. Promotion of public-private partnerships in this realm can reinforce the goals of both government and industry.

One example of this kind of public-private collaboration is the U.S. Energy Association (USEA), which is the U.S. member committee of the World Energy Council. The USEA

comprises public and private energy-related organizations, corporations, and government agencies. USEA has organized over 75 cooperative partnerships between U.S. organizations and counterparts in developing and transitional economies. Through these partnerships, U.S. organizations have conveyed U.S. experiences, and business and regulatory practices to other nation in Latin America, Africa, Asia, the former Soviet Union and Central & Eastern Europe. Focus areas have included petroleum exploration, production and transportation; natural gas distribution; and electric power production, transmission, distribution and utilization (USEA 2004).

Another example is the India-U.S. National Academies Committee on Energy and Environmental Cooperation. This committee, composed of senior energy-policy leaders and experts from national laboratories, industry, and academia from both countries, meets regularly to discuss energy-related issues of concern to both sides, and is currently working on a study to explore possibilities for enhanced energy and environmental cooperation between the two countries. It has chosen five high-priority foci for this study: clean fossil fuels (including clean coal technologies and the potential of gas hydrates); realistic applications of renewable energy sources; approaches to reducing greenhouse-gas emissions (including use of the Clean Development Mechanism and other "win-win" approaches); reducing electrical power shortfalls (including improvements in generation, transmission, and distribution); and clean-vehicle technologies. A similar U.S.-China National Academies Committee completed its work in 2000 with publication of a blueprint for future U.S.-China cooperation in energy-technology innovation (NRC 2000).

U.S. Agency for International Development (USAID)

The U.S. Agency for International Development engages in many international energy collaboration activities in its efforts to promote economic development and alleviate poverty in developing countries. Energy services such as electricity and heating are essential contributors to human well-being.

One example of USAID's work on energy is its rural electrification program in Bangladesh, where only 20 percent of the population has access to electricity. USAID, working with the National Rural Electric Cooperative Association (NRECA), pioneered the Rural Electrification Program, which now brings electricity to over 20 million people across rural Bangladesh. This program promoted the establishment of the Rural Electrification Board as a semi-autonomous agency under the government of Bangladesh, using rural electric cooperatives for service delivery. Since Bangladesh is primarily an agricultural country, the main beneficiaries of rural electrification are farmers. The availability of electricity in rural areas has made possible the use of over 110,000 electric irrigation pumps. As a result, farmers now have expanded access to low-cost, dry-season irrigation, contributing to increased agricultural production and improved food security. There have also been many secondary benefits related to power generation such as improved literacy, better family planning, and enhanced incomes (USAID 2004).

A major limitation for USAID's energy-related work is that it is not permitted to fund efforts in China, the second-largest energy consumer in the world, because of China's political

system. The logic of this prohibition on publicly-funded efforts to help alleviate poverty is seriously flawed in light of the fact that U.S. firms are not only allowed, but are actually encouraged to invest in profit-gaining activities in China.

U.S. Trade & Development Agency (TDA)

The U.S. Trade and Development Agency's (TDA) mission is to advance economic development and U.S. commercial interests in developing and middle-income countries. The agency funds various forms of technical assistance, feasibility studies, training, orientation visits, and business workshops that support the development of modern infrastructure and trade practices. TDA uses foreign assistance funds to support sound investment policies in host countries to create an enabling environment for trade, U.S. investment, and sustainable economic development. TDA gives emphasis to economic sectors that would benefit from U.S. exports of goods and services (USTDA 2004). One example of TDA's work in an energy-related example is a technical assistance and capacity building project in Mexico that was approved in 2003 to work on Intelligent Transportation Systems with Mexico's Secretariat for Communication and Transportation at the level of $431,000 (USTDA Latin America 2003).

In January 2001, TDA was re-authorized to operate in China after an eleven-year ban. TDA had been prohibited to work there before then, but is now prioritizing projects involving environmental protection, energy development, and aviation safety and navigation (Gallagher 2001).

Export-Import Bank

The Export-Import Bank of the United States (ExIm Bank) is the official export credit agency of the United States. ExIm Bank's mission is to assist in financing the export of U.S. goods and services to international markets. ExIm Bank provides working capital guarantees (pre-export financing); export credit insurance (post-export financing); and loan guarantees and direct loans (buyer financing). On average, 85 percent of ExIm Bank activities directly benefit U.S. small businesses. With nearly 70 years of experience, ExIm Bank has supported more than $400 billion of U.S. exports, primarily devoted to developing markets worldwide (ExIm Bank 2004).

The ExIm Bank has supported many firms in the energy sector, and it has also developed special initiatives to focus on the deployment of environmental technologies, including cleaner energy technologies. For example, in 1999 a memorandum of understanding was signed between the ExIm Bank, U.S. Department of Energy, China Development Bank, and China State Development Planning Commission to establish a program to encourage U.S. firms to speed the deployment of clean energy technologies in China. In 2002, it established a Renewable Energy Exports Advisory Committee to assist the Bank in expanding its support for U.S. exporters in renewable energy industries, including solar, wind, geothermal, hydroelectric, and biomass sectors. In the natural gas arena, the ExIm Bank supported $2.8 billion in projects involving natural gas exploration, pipelines, and liquid natural gas (LNG) facilities. Two major natural gas projects are the Sakhalin II project in Russia and a project related to the expansion of the LNG plant in Qatar (Merrill 2003).

Overseas Private Investment Corporation (OPIC)

Like the Export-Import Bank, the Overseas Private Investment Corporation (OPIC) provides support for U.S. firms who are investing in foreign countries. OPIC charges user-fees for its services, and thus it currently operates at no net cost to the American taxpayer. It provides political risk insurance, project finance, and investment funds to U.S. businesses. Since its inception in 1971, OPIC has supported approximately $145 billion worth of investments.

A significant amount of OPIC funding goes into the energy sector. OPIC is beginning to consider how its energy investments might be affecting the global environment, and it conducted a review of its activities with respect to their impact on global climate change in 2000. This review concluded that CO_2 emissions from OPIC-supported projects represent 0.24 percent of cumulative greenhouse-gas emissions. In terms of OPIC's investments in power plant projects, 45 percent are gas-fired, 24 percent hydro, 21 percent coal-fired, 7 oil-fired, and 3 percent geothermal. Many of these projects are reported to be highly efficient, with 43 percent utilizing combined-cycle technologies (OPIC 2000).

Bilateral Initiatives and Agreements

Bilateral agreements are used by the U.S. government to formalize collaboration on energy-related issues. Two prominent examples of existing bilateral agreements are the two scientific-cooperation agreements between the European Commission and the United States on energy research (fusion and non-nuclear energy) and the U.S.-China Protocols on Cooperation in the Fields of Fossil Energy and Energy Efficiency and Renewable Energy, which are part of the overall 1979 Framework Agreement on Cooperation in Science and Technology.

These bilateral agreements are often expressions of broad intent, and actual activities are specified later in the form of annexes or informal arrangements. The bilateral agreements serve a critical purpose in providing official endorsement of inter-governmental activities at the agency level, and in providing forums for high-level officials to exchange views and deepen their understanding about the conditions and challenges in the other country. A limitation is that the bilateral agreements often lack the specificity to result in actual project-based activities. To the extent that priorities and goals are explicitly articulated, funding is not always provided by the United States to implement the agreement.

International Energy Agency (IEA)

The International Energy Agency (IEA) was established in November 1974 by the Organization for Economic Cooperation and Development (OECD) to implement a program of energy cooperation among member countries.[2] The basic aims of the IEA are to reduce excessive dependence on oil through energy conservation, to work on the development of alternative energy sources, and to conduct energy research and development. IEA also maintains an information system on international oil markets, and cooperates with oil-producing countries

[2] IEA member countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the UK, and the United States of America.

to develop a stable system of international energy trade. The IEA is funded by its members, voluntary contributions, and from income from sales of publications. As of 1993, the United States provided a quarter of the agency's budget (Scott 1994).

Other Multilateral Agreements and Initiatives

Multilateral energy agreements encompass a wide range of topics, including security and environment, that are of common interest to the United States and other countries. They often serve to create international norms for behavior, but are difficult to enforce. Examples of intergovernmental agreements include the Kyoto Protocol to the 1992 U.N Framework Convention on Climate Change, the 2001 International Convention on Civil Liability for Bunker Oil Pollution Damage, and the Nuclear Non-Proliferation Treaty. Initiatives less formal and binding than treaties and conventions also abound; an example is the US-initiated International Carbon Sequestration Leadership Forum.

4.0 Examples of International Energy Collaboration Projects and Programs

Greenhouse Gas Technology Information Exchange (GREENTIE)

GREENTIE was formed by the International Energy Agency in October 1993, and its aim is to identify greenhouse gas mitigation technologies that could be deployed internationally, and then publicize the availability of these technological options. Currently 19 countries participate in this collaboration, including the United States. GREENTIE's main product is a directory of information about suppliers of products, technologies, and information related to the mitigation of greenhouse gases (Brown et. al 1995).

Carbon Sequestration Leadership Program

The Carbon Sequestration Leadership Forum is an ongoing international climate change initiative that is focusing on development of carbon capture and storage technologies as a means to accomplishing long-term stabilization of greenhouse gas levels in the atmosphere. This initiative is designed to improve carbon capture and storage technologies through coordinated research and development with international partners and private industry.

ITER

ITER is an international research collaboration to develop fusion nuclear power. This collaboration includes scientists and engineers from China, Europe, Japan, Korea, Russia, and the United States. According to ITER, its mission is to, "demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes." It plans to demonstrate essential fusion energy technologies in a system integrating the appropriate physics and technology, and test key elements required to use fusion as a practical energy source. ITER also aims to eventually demonstrate fusion power in an actual power plant (ITER 2004).

International Partnership for a Hydrogen Economy

The International Partnership for a Hydrogen Economy (IPHE) was initiated by the United States in 2003 to focus on the development of hydrogen-powered vehicles. Because a hydrogen-based energy system would require a world-wide infrastructure for the production, storage, transportation, distribution, and use of hydrogen, it makes sense to conduct research, development, and demonstration activities in a multilateral setting.

The U.S. Department of Energy states that the Partnership will encompass, "collaborative and cooperative efforts to advance research, development and deployment of hydrogen production, storage, transport and distribution, fuel cell technologies, common codes and standards for hydrogen fuel utilization, and coordination of international efforts to develop a global hydrogen economy." From DOE's perspective, the ultimate goal of the IPHE is to create a competitively priced hydrogen-powered vehicle that can be refueled near people's homes and places of work (U.S. State Department 2003).

Energy-Efficiency Centers in Eastern Europe, the Former Soviet Union, and China

In 1990, the U.S. government began creating energy-efficiency centers in the centrally-planned economies of the former Soviet Union and China. The centers were each provided with three years of funding by the U.S. government, World Wildlife Fund, the MacArthur Foundation, and the C.S. Mott Foundation, staffed with in-country experts, and required to become self-financing after three years. The centers provide policy analysis for reform and efficiency, business development through market conditioning and assistance to private firms, training in finance and demonstrations of new technologies, and public education and outreach (PCAST 1999).

5.0 Findings of Previous Studies

There have been few studies of U.S. international energy cooperation in its broadest sense, but many have focused on particular aspects of global energy needs that in turn have implications for U.S. energy cooperation with individual countries. The most recent comprehensive study on this topic was conducted by the President's Council of Advisors on Science & Technology (PCAST) in 1999 entitled, "Powerful Partnerships: The Federal Role in International Cooperation on Energy Innovation." This study concluded that there were four main foundations for energy-technology innovation and related cooperation that would enable more collaborative activities to occur: capacity building, energy sector reform, demonstration and cost buy-downs, and financing mechanisms. The panel recommended that more focus be placed on cooperation for improving the end-use efficiency of many technologies, cooperation on technologies for energy supply, and improved management of the U.S. federal government's activities in energy-technology innovation cooperation (PCAST 1999).

The 2000 World Energy Assessment argues that the first priority of energy policy should be to provide modern energy services to the one-third of the world's people who subsist on traditional and inefficient sources of energy. The WEA thus recommends improving access to efficient cooking fuel, making electricity available to satisfy both basic needs and to support

local economic development, and to develop new structures and partnerships for the provision of rural energy services. The WEA also encourages greater international energy cooperation and through the transfer of technology and the building human and institutional capabilities in developing countries (WEA 2000).

The 2001 World Energy Council report recommended that energy-technology spending and technology transfer needed to be increased in nearly every country and internationally. The WEC recommended that priorities should be to increase energy efficiency, accelerate the deployment of locally appropriate renewable energy-technologies, respond to public concerns about nuclear energy, and to allow carbon sequestration (WEC 2001).

The 2004 World Energy Assessment Update reiterated many of the concerns about rural energy development, and also highlighted the particular importance of harnessing rising energy consumption in the transportation sector. For most industrialized countries including the United States, transportation is the largest and fastest-growing consumer of energy. The 2004 WEA argues that the growing dependence on oil is even more serious in developing countries where transportation energy demand is growing three times faster than in industrialized countries. Again, the WEA encourages enhanced international cooperation to address these and other energy challenges. Particular areas of focus recommended by this study include joint government procurement of renewable energy technologies, harmonization of environmental taxes, international greenhouse gas emissions trading, and common energy efficiency standards and codes. The authors also argue for "concerted action" to implement the various international energy and environmental agreements that have been negotiated in recent years (WEA 2004).

In the category of analyses of international energy cooperation between particular countries, a recent study of note was the study on "Cooperation in the Energy Futures of the United States and China" conducted by the U.S. and Chinese Academies of Sciences (NRC 2000). This report explored the similarities and differences between the energy systems of the United States and China, and concluded that there was ample scope for greater energy cooperation between the two countries given many common challenges.

7.0 Conclusions and Recommendations

In our judgment, the scope and scale of U.S. government international energy cooperation is not commensurate with U.S. interests, needs, and opportunities in this area. U.S. economic and political interests in affordable and reliable energy supplies for itself and for the rest of the world are immense. In addition, this country and the world are highly vulnerable to energy-induced environmental problems that cross national boundaries (including the global problem of climatic disruption by greenhouse gases), as well to global consequences from accidents and sabotage at energy-supply facilities and from diversion of nuclear materials from civilian (as well as military) stockpiles. These interests and liabilities are not now and will not soon be captured in energy prices so they are not (and will not soon be) fully addressed in the energy marketplace. This situation warrants government investments not only in domestic efforts to close the gap between public and private interests in energy choices, but also in international cooperation to address the dimensions of these issues that cannot be addressed by domestic initiatives alone. Our specific recommendations follow.

FUNDING-RELATED RECOMMENDATIONS

Increase the Scale of Funding for International Cooperation on Energy-Technology Innovation

We concur with the conclusion of the 1999 PCAST study that U.S. investments in international cooperation on energy-technology innovation (research, development, demonstration, and early deployment) should at least be tripled from their late 1990s level -- that is, from circa $250 million per year to circa $750 million per year. The greatest emphasis in this expanded effort should go to cooperation with those countries that offer the highest leverage in addressing the major energy-related challenges of the twenty-first century.

Energy efficiency is usually the cheapest and cleanest new "source" of energy in any context. More technical and policy assistance is needed for the development and implementation of efficiency standards and design software that helps to minimize energy use. Also, measures are needed to help reduce the energy intensity of the industrial sector in many developing countries as well as in the electricity sector where technologies such as co-generation (or combined heat and power) can be deployed.

The transportation sector is becoming a huge source of increasing demand for oil supplies in many developing countries, and it is also a huge increasing source of air pollution and greenhouse gases. Automobile sales in China, for example, have recently been increasing at a rate of 40-60 percent annually. Many developing countries need technical assistance with respect to managing the environmental side-effects of automobiles (such as designing and implementing emissions standards, fuel quality standards, fuel-efficiency standards, and inspection and maintenance programs). These countries also need help with urban design and transportation planning in order to provide alterative forms of transportation. Many countries are especially eager to cooperate on energy innovation activities for transportation, and the U.S. government should support cooperative RD3 on low-cost, clean, and efficient power sources for transportation. USAID and EPA have a special role to play in technical assistance, in coordination or support of civil society actors (such as universities and research institutes) who are already working in these areas with partners in developing countries.

Nuclear energy may have to play a role in addressing climate change and other energy-related challenges, so it is important to maintain U.S. government support for international collaboration on nuclear energy, especially with respect to securing nuclear materials and minimizing the risks associated with nuclear proliferation. Cooperative international R&D for fusion energy is essential because this allows the U.S. to share costs related to fusion energy development, a technology that remains far from commercially viable. It is also important to strengthen collaborative efforts with other countries that house commercial nuclear reactors regarding geological disposal of spent fuel and high-level wastes (PCAST 1999).

China and India are the largest consumers of coal in the world aside from the United States, and so it will be particularly difficult for them to reduce conventional air pollution and greenhouse-gas emissions while they are in a phase of rapid coal-based industrialization. China is the fastest-growing consumer of oil in the world, and like the United States China is likely to

become ever more dependent on Persian Gulf oil supplies unless alternatives are aggressively developed.

Although the largest part of U.S. government investment in demonstration and early deployment of energy technologies should and will take place in the United States, it is in the U.S. interest to support demonstration activities abroad as well. Conditions in other countries may be quite different from U.S. conditions, so demonstration of a technology in the United States does not necessarily mean that the technology will work elsewhere.

A perfect illustration of this problem is in the area of clean coal. Coal properties in China vary substantially from U.S. coal properties particularly with respect to ash and sulfur content where Chinese coal has higher percentages of both. The average sulfur content of Chinese coal is 1.1% versus 0.93% in the United States, and the average ash content of Chinese coal is 23.4% compared with 8.8% in the United States. In the case of mercury, the average mercury content of coal in China is actually less than it is in the United States. When considering coal gasification, the high ash content of Chinese coal will affect the gasification process significantly, rendering some U.S. gasification technologies ineffective without modification. In other words, it will not be possible do develop and demonstrate clean coal technologies in the United States and simply export them to other countries without demonstrating them in the other countries first.

There is a strong need in many developing countries to provide sources of financing for clean and energy-efficient technologies. In many cases, financing is not available in these developing countries because banks are unfamiliar with the technologies, or because the levels of financing required are either too small or too large. More financing mechanisms need to be designed and deployed, at competitive rates, for developing countries. In most, if not all cases, these mechanisms should be self-sustaining once a pool of money has been allocated for this purpose.

Increase Financial Support for Civil-Society Energy Collaboration Projects

The U.S. government has tended to support private sector and government-to-government energy collaboration activities more than it has supported activities initiated by members of civil society, such as research institutes, non-governmental organizations, and universities. More resources are needed both for the governmental activities, and also for these civil-society activities.

Invest in Gaining a Better Understanding of International Energy Cooperation

As has been mentioned already, it is not exactly clear how much money the U.S. government spends on international energy cooperation activities, so an updated study of this nature is badly needed. In addition, there have been few systematic analyses of U.S. international energy cooperation programs and activities. More attention is needed to understanding the processes of technology transfer, international deployment of energy technologies, and the linkages between the public and private sector in collaborative activities.

We recommend that a modest but crucial $5 million be allocated per year for the purpose of increasing our understanding of U.S. international energy cooperation.

INSTITUTIONAL RECOMMENDATIONS

Form an Interagency Working Group on Strategic Energy Cooperation

U.S. international energy cooperation is not coordinated among the U.S. government agencies in any systematic way. An inter-agency working group should be established to create a coherent strategy with respect to energy cooperation, implement it, and evaluate the successes and failures.

CROSS-CUTTING RECOMMENDATIONS

Bring More Political Leadership to Bear on International Energy Collaboration

Because the rationales for international energy collaboration require an understanding about how other countries' policies and development might affect U.S. interests, political leadership is required to garner public support for these types of activities.

Reform U.S. Visa Policies

One more newly-formed barrier to international technical and policy-related exchanges is that foreign experts are unable to get visas to visit the United States even for basic conferences and workshops. Undergraduate, graduate, and post-graduate students are being denied visas even in the face of strong support of U.S. universities. This practice is generating frustration and humiliation at the least, and animosity at the most, among those with whom we will need to cooperate on energy matters into the future.

Stress International Energy Collaboration as a Key Ingredient of Climate-Change Policy

International energy collaboration is essential to reduce the risks of climate change. Many developing countries lack the knowledge or resources to significantly reduce greenhouse-gas emissions. Per capita income in India and China, for example, is only $2,840 and $4,020 respectively (UNDP 2003).[3] U.S. leadership in establishing cooperative programs with these types of developing countries could go a long way towards improving intergovernmental policy on climate change because the United States would be perceived to be trying to help the less-advantaged countries cope with the dual problems of economic development and environmental protection.

Relevant in this connection is not only international collaboration on innovation in low-carbon technologies but also helping developing countries build capacity for reducing greenhouse-gas emissions (through policy analysis and implementation, training, and information-sharing). On the technology-innovation side, programs should be established to focus on technologies that reduce greenhouse-gas emissions (through, e.g., increased end-use

[3] Purchasing-power parity adjusted gross domestic product, in U.S. dollars.

efficiency, renewable energy, and advanced coal-fired generation technologies with carbon capture and sequestration), on policies that will help deploy these low-carbon technologies, and on technical assistance for actually implementing the policies and programs.

Assist with Energy Sector Reforms in Developing Countries

A major barrier for expanding markets for U.S. energy goods and services is the slow pace of energy sector reforms in many developing and former Soviet Union countries. Most of these countries need assistance in moving towards open competitive markets

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